

WHAT IS CLAIMED IS:

1. A wavelength converter using different frequency generation (DFG) comprising:
  - (a) a first optical filter configured to filter out one or more lightwaves requiring wavelength conversion from wavelength-division multiplexed (WDM) lightwaves; and
  - (b) a broadband multi-channel simultaneous wavelength conversion portion comprising a pump source that generates pump light for use in the process of the DFG, a first optical combiner for combining said pump light with said filtered lightwaves, a high non-linear medium configured to generate wavelength converted lightwaves from said filtered lightwaves using DFG, and a second optical filter for filtering said wavelength converted lightwaves from said filtered.
2. The wavelength converter according to claim 1, wherein said high non-linear element comprises a quasi-phase-matching (QPM) construction.
3. The wavelength converter according to claim 2, wherein said higher non-linear element comprises a periodically poled LiNbO<sub>3</sub> (PPLN) waveguide.
4. The wavelength converter according to claim 1, wherein said first optical filter is configured to filter out one or more lightwaves from each N channels of a lightwave, where N is a positive integer.
5. The wavelength converter according to claim 1, wherein said first optical filter comprises a dielectric multi-layered filter configured to filter out one or more clusters of lightwaves (sub-bands) in wavelength domains.
6. The wavelength converter according to any one of claims 1 to 5, wherein a second optical combiner is connected after said broadband multi-channel simultaneous wavelength conversion portion and said first optical filter, and wherein said second optical combiner is configured to combine output lightwaves of said broadband multi-channel simultaneous wavelength conversion portion with lightwaves not inputted to said broadband multi-channel simultaneous wavelength conversion portion by said first optical filter.
7. The wavelength converter according to any one of claims 1 to 5, wherein a second optical combiner is connected after said broadband multi-channel simultaneous wavelength conversion portion and is configured to combine output lightwaves of said broadband multi-

channel simultaneous wavelength conversion portion with externally launched WDM lightwaves.

8. The wavelength converter according to claims 6, wherein an optical demultiplexer is connected after said second optical combiner to demultiplex output lightwaves of said second optical combiner.

9. The wavelength converter according to claim 1, further comprising:

another broadband multi-channel simultaneous wavelength conversion portion connected in series with said broadband multi-channel simultaneous wavelength conversion portion to convert wavelength of lightwaves filtered out by said first optical filter,

wherein wavelength of lightwaves filtered out by said first optical filter are converted without losing any information carried by the lightwaves.

10. The wavelength converter according to claim 1, further comprising:

(c) an optical divider having first and second ports for outputting two groups of lightwaves filtered out by said first optical filter; and

(d) an optical combiner for combining lightwaves output on said first port of said optical divider with lightwaves not inputted to said optical divider by said first optical filter; and

(e) another broadband multi-channel simultaneous wavelength conversion portion connected in series with said broadband multi-channel simultaneous wavelength conversion portion to convert wavelengths of lightwaves output on said second port of said optical divider.

11. The wavelength converter according to claim 10, wherein an optical amplifier is inserted between said optical divider and said optical combiner to amplify output lightwaves from said optical divider.

12. The wavelength converter according to claim 1 further comprising:

(c) a second optical filter configured to filter out one or more lightwaves required to be wavelength converted from lightwaves not inputted to said broadband multi-channel simultaneous wavelength conversion portion by said first optical filter; and

(d) another broadband multi-channel simultaneous wavelength conversion portion configured to convert wavelength of lightwaves filtered out by said second optical filter; and

(e) a second optical combiner for combining output lightwaves from said other broadband multi-channel simultaneous wavelength conversion portion with lightwaves not inputted to said other broadband multi-channel simultaneous wavelength conversion portion by said second optical filter; and

(f) an optical wavelength combiner to combine output lightwaves from said broadband multi-channel simultaneous wavelength conversion portion with output lightwaves from said optical combiner.

13. The wavelength converter according to claim 12, wherein an optical demultiplexer is connected after said optical wavelength combiner to demultiplex output lightwaves of said optical wavelength combiner.

14. The wavelength converter according to claim 1, further comprising:

(c) an optical divider configured to divide WDM lightwaves into one or more groups of lightwaves required to be wavelength converted and lightwaves not required to be wavelength converted; and

(d) an optical combiner configured to combine lightwaves in said one or more groups of lightwaves not required to be wavelength converted with converted lightwaves from said broadband multi-channel simultaneous wavelength conversion portions, wherein at least one broadband multi-channel simultaneous wavelength conversion portion is configured to convert wavelengths of said lightwaves in said one or more groups of lightwaves required to be wavelength converted.